PTX-RSI at 7T: Fast in-vivo brain spectroscopic imaging at UHF using an 8-channel parallel transmit system, a shim gradient insert coil and rosette trajectories.

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TARGET AUDIENCE: Neuroscientists, researchers interested in fast brain MRSI (sequence development, non-Cartesian acquisitions, PTX, UHF), potential clinical use.

PURPOSE: While 7T systems provide the benefit of increased SNR, MR spectroscopic imaging (SI) at UHF (7T and above) is limited by inhomogeneity artifacts, high SAR (specific absorption rate), and long acquisition times. The aim of this work is to develop and implement a fast MRSI acquisition technique, suitable for use in-vivo human brain on a 7T MR system, in clinically acceptable times.

METHODS: The technique was implemented on a 7T scanner (Siemens, Erlangen, Germany) capable of slew rate SR=170mT/m/ms and G=40mT/m. An 8-channel PTX system (Siemens, Germany) was used to drive an 8-channel single row transmit/receive head coil providing effective lipid suppression as described in (1). This excitation scheme allows for lower SAR than obtainable with a PRESS/LASER scheme and SI data can be obtained closer to the scalp and regions like prefrontal cortex can be potentially explored. We used TR/TE=1500/40 ms. A coil insert with up to 4th order shims was used to adjust the field homogeneity as described in (2); B1 and B0 shimming was performed. Data acquisition was performed using rosette trajectories (RSI). The trajectories were designed and data reconstructed as described in (3). A target FOV=20cm, Nx=24, and spectral width SW=3kHz were used. The maximum SR was constrained to 150mT/m/ms, the complex data sampling rate was 5us, readout time 160ms. The number of trajectories needed for proper K-t sampling is Nsh=60 shots. Maximum gradient along the trajectory was 13.28mT/m. No temporal interleaving was necessary. Four averages for one slice (thickness 1cm) were collected in 6 mins. One water reference data set was collected in 15 seconds (TR=250ms, 60 shots). ***Simulations:*** The PSF for this acquisition scheme was simulated (Fig 1, red, FWHM=0.92cm, 1st lobe is -16% of maximum) and compared to CSI (Nx=24, FOV=20 cm) w/ elliptical encoding (blue, x-dir PSF FWHM=1.07cm, 1st lobe is -14% of max) and w/o elliptical encoding (green, x-dir PSF FWHM=0.83cm =20cm/24, 1st lobe is -22% of max). The effective voxel volume (defined by contour at half max of peak) was also calculated for RSI and CSI by increasing the (digital) resolution by a factor of 10 in both x- and y-dirs (thus, one voxel becames 10x10 =100 smaller voxels for more precise PSF calculations). For a 1cm slice thickness (as used here), the effective voxel volume calculated for RSI is 0.98cc, for elliptical CSI is 1.30cc and for square CSI is 0.82cc. However, when windowing with a Hamming filter (PSF 1st lobe less than 1% of maximum for both CSI and RSI), the effective voxel volume for RSI increases only to 1.88cc, while both elliptical and square CSI voxels increase to 2.37cc.

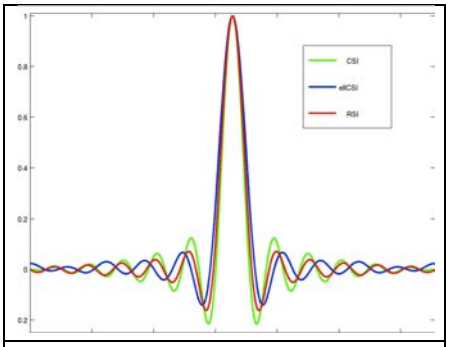

Fig 1:. *RSI PSF (red) compared to x-direction PSF for CSI with elliptical encoding (blue) and w/o (green)*

RESULTS: In Fig 2, spectra for a couple of locations are shown.

DISCUSSION: The high SNR observed suggests one average (1.5min) may be sufficient (SNR drops to half) fro the one slice acquired. Extending this acquistion scheme to 3D (classic encoding for z-dir) or multi-slice w/ Hadammard encoding would allow for increased coverage in clinically acceptable times (<10mins).

CONCLUSION: High resolution, fast MRSI is feasible at UHF.

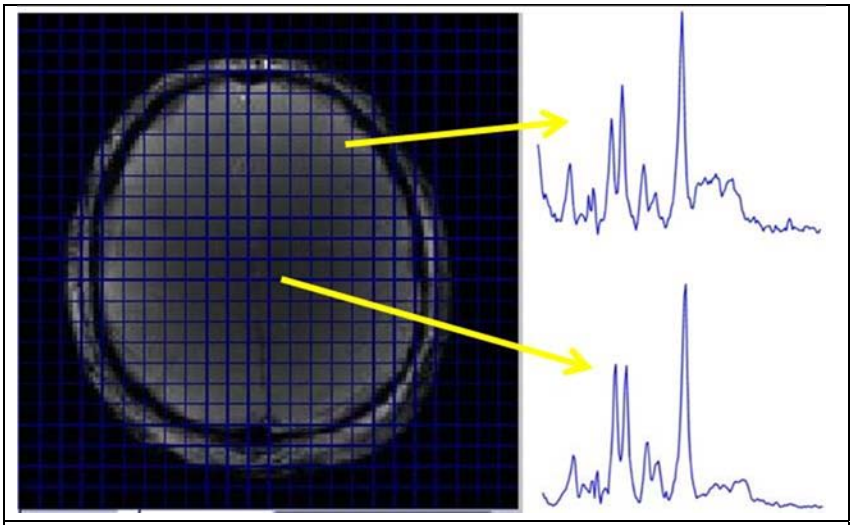

Fig 2: *Localizer image used to prescribe the MRSI acauisition. Spectra (below 4.5ppm) for a couple of locations.*

References:

1) Hetherington HP, Avdievich NI, Kuznetsov AM, Pan JW, RF Shimming for Spectroscopic Localization in the Human Brain at 7T, MRM 2010 Jan;63(1):9-19.

2) Pan JW, Lo KM, Hetherington HP. Role of very high order and degree B0 shimming for spectroscopic imaging of the human brain at 7 tesla. MRM 2012 Oct;68(4):1007-17

3) Schirda CV, Tanase C, Boada FE. JMRI 2009 Jun;29(6): 1375 -85.